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Analysis of KSTAR SOL power and momentum loss using SOLPS and Two-point formatting equation

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An electron density scan of the KSTAR plasma was performed using the SOLPS-ITER code to understand divertor detachment. The SOLPS result was post-processed on three divertor conditions: low recycling, high recycling and detached regime. The divertor conditions were classified by the ion particle flux on the target among density scan cases. The particle, momentum and power balances along and across the flux tubes were investigated for each divertor condition in terms of source term decomposition. The balance result indicates that the volumetric loss terms due to the EIRENE reactions (charge exchange, electron impact ionization, molecule dissociation, volume recombination, etc.) are dominant loss mechanism, hence enhancing detachment at high density. The losses due to radial diffusion at near SOL is comparable to the EIRENE reaction source and is not negligible as in the basic two-point model (2PM). The basic two-point model (2PM) predictions and SOLPS result were compared with each other and the validity of the assumptions in the basic 2PM was investigated. The basic 2PM predicts the target parameters well at relatively low densities prior to detachment, but it deviates at high density thus it is not capable of extrapolate to future devices. The two-point formatting equation (2PMF), which takes account for various volumetric processes as loss factors, was compared with the SOLPS results again. Correction of the 2PMF equation from the 2PM was performed mostly by volumetric loss terms. The ‘other’ loss terms, including magnetic flux expansion factor, ion-electron temperature difference, and Bohm sheath condition correct the 2PMF accurately. A density scan using SOLPS predicts that outer divertor detaches at a relatively low density than the inner divertor. This predicted detachment behavior is observed in the 2017 KSTAR divertor detachment experiment where the outer divertor first detaches and then the inner divertor begins to rollover at a higher density as the density increases.